Centauri Energy Server
Product Overview

The Centauri Energy Server is a stand-alone, modular, plug-and-play, hardware and software platform that aggregates energy generated from multiple input sources, regulates and controls distribution of the energy to load and storage during generation, and then from storage to load when there is no renewable generation. The Server independently handles peak load without grid or gen set support.

A comparison of selected features of the Centauri Energy Server with smart inverters / PCS:

Feature	Centauri Energy Server	Smart Inverter / PCS
Pure Sine Wave Resolution	High resolution 1024 bit high speed switching	Standard resolution 16 bit
AC Overload (Torque Load) Setting	1000% for 2s	~150% - 250% for 15s
	999% to 200% for next 8s	
	200% for next 180s	
DC - AC System Efficiency	96.7% on reactive load & 99.1% on resistive load	~80%
Solar Charge Controller / Wind Charge Controller	Standard MPPT + proprietary charge algorithm increases battery capacity of select batteries by 40% and enables elimination of DOD limitation	Standard MPPT only
Battery Balancing	Continually monitors and balances batteries at the individual cell level for 2V/12V Lead Acid/AGM/Gel/Flooded/Li Ion/Supercap batteries - which increases battery life	Not available
Multiple Input Generation Sources with Blended Output	PV solar, wind, diesel generator, grid, geothermal, battery, or any other AC or DC source can be concurrently connected as input and blended in a user determined percentage and delivered as regulated output	Not available
Multiple Input Source Switching	Available	Not available
Switching Time between Input Sources	0.00ms	Not Available
Switching Time to Bypass Mode	4ms	
Power Factor Correction on Load	Actively corrects power factor on load to 1	Not Available
Harmonics Filtering	Actively filters harmonics generated by reactive loads	Not Available
Monitoring	Built-in Standard. Unique user programmable data logging interval between 100ms to 10s, and data storage of all logging events on the Server's hard drive	Not available - added as accessory
Bypass Mode	Available	Not Available
Static Bypass	4ms switching time	
Auto Bypass	Overload or short circuit	
Manual Bypass	Available	
Auto Gen Start	Available	Not available

1. Introduction

Renewable generation is being fed into the grid network (utility scale or rooftop) but the grid network is not designed to accept an intermittent, non-dispatchable, low capacity factor, bi-directional (in the case of rooftop) generation source. Therefore, there are significant technical challenges arising in the grid network as renewable penetration increases, and importantly, significant commercial challenges arising as the renewable industry tries to balance its needs with that of the network operators.

The reason that renewable generation can only be fed to the grid is the limitation of power control electronics.

The Centauri Energy Sever is a proprietary control electronics platform (hardware + software) that is a technically and commercially deployable solution enabling microgrids with high (up to 100%) renewable generation and storage.

The Centauri Energy Server has been designed to deliver customer-centric and customer sited renewable based solutions that work technically and independently of the grid. It is available in configurations from kW to MW.

The following sections describe the unique features, applications and technology of the Centauri Energy Server.

2. Unique Features

2.1. Torque Load Handling

The Server's power module (inverter) generates a sine wave curve at a very high resolution of which enables it to handle torque loads (surge currents generated when devices such as motors and air-conditioners start) of up to 1000% of its rated capacity. The Server, therefore, handles peak loads without the support of the grid or generators.

2.2. Efficiency

The Server operates at high input DC voltage (192VDC – 1200VDC) depending on Server model). This coupled with the high-resolution sine wave results in high DC to AC efficiency. The Server's power module DC to AC efficiency is 96.7% for reactive loads and 99.1% for resistive loads.

2.3. Energy Blending from Multiple Sources

The Server's accepts multiple input generation sources concurrently and delivers regulated output in a user determined percentage. The generation inputs that can simultaneously be connected to the Server include PV solar, wind turbines, diesel generator(s), grid, geothermal, batteries, or any other AC or DC source.

2.4. Input Source Switching

The Server's unique chassis architecture and design enables seamless switching between input sources. This feature controls intermittency of renewable generation inputs, thereby delivering stable and regulated power output.

2.5. Power Factor Control

The Server actively corrects power factor of the *load* to 1, using a single, large capacitor / inductor as a digitally variable capacitor / inductor.

2.6. Harmonics Filtering

The Server's harmonics filter connected on the output power line actively analyses and changes RLC values to filter out resonated harmonics frequencies generated on the line through variable reactive loads.

2.7. Monitoring

The Server's monitoring functionality delivers a user programmable data logging interval, as well as data storage of all logging events on the Server's hard drive. This allows the operator the ability to monitor each system, predict failures at the individual system level, isolate faults from the network etc. In addition to enabling user programmable logging and in-built data storage, the Server's monitoring has the following functionality:

- It is fully compatible with all known protocols (read / write) like Modbus, Profibus, CAN etc.
- It stores all logging files of all events that occur during the life of the Server which include:
  - PV input metrics
  - Battery input / output metrics of every battery cell connected to it
  - Wind input metrics
  - Diesel generator input metrics
  - Grid input metrics
  - Load metrics

2.8. Redundancy

Multiple microcontrollers simultaneously control all components and functions of the Server through a common communication bus. In the event that one microcontroller hangs, the watchdog microcontroller seamlessly transfers the control to the redundant microcontroller within the same machine cycle so there is no loss of instruction and the control remains uninterrupted. The third microcontroller always remains as a backup and maintains the storage of different settings and sensors data. Making the Server a robust and resilient control device requiring minimal maintenance and monitoring.

2.9. Stand-alone Platform

The Server is unique in that all hardware components and software based functionalities are delivered in a plug-and-play, stand-alone platform. This results in efficient and seamless and fast communication between all components, maximizing energy efficiency across operations, reducing paths to failure in installation, eliminating dependency on external components and delivering the fastest go-to-generation time in the industry.

2.10. Modular Architecture

The Server architecture is modular, chassis based. This enables the Server's capacity and functionalities to be added / and or increased as user requirements evolve. This provides a platform with the ultimate flexibility. The Server chassis has "hot swappable" functionality, which means that modules can be changed without shutting down the system.

2.11. Bypass

The Server is embedded with static, manual and auto bypass capabilities to provide maximum safety during operation.

2.12. Battery Balancing

The Server actively monitors and balances the batteries at the individual cell level thereby protecting connected batteries from damage due to overcharging. This is available for 2V / 12V lead acid / AGM / gel / flooded batteries, Lithium Ion cells and Supercap based storage.

This is a very critical feature in ensuring connected storage operates at maximum efficiency and safety to deliver the longest cycle life.

2.13. Solar and Wind Module

In addition to standard MPPT function, the solar and wind modules regulate and maximize usage of electrolyte capacity in the batteries resulting in increasing standard Lead Acid / AGM / Gel available capacity by up to 40%.

2.14. Islanding / Anti-Islanding

With the Server's bi-directional module, the Server seamlessly islands from the grid, and reconnects to the grid, and can respond directly to the signals from the network operator. The transition, in either direction, is automated and is possible as a result of the Server's architecture and communication protocols.

2.15. Automatic Frequency Selection

The inverter automatically detects operational frequency between 50 Hz or 60 Hz.

2.16. Intelligent Communication Interface

The Server supports RS232, USB or RS485, SNMP monitoring interface protocols and can be connected to a PC for monitoring. The PC operating systems supported by the Server include Windows/NT/2000/ME/2003/XP/Vista and Mac IoS. This enables automatic logging of events on a PC.

2.17. Auto generator start

The Server's generator module interfaces with most commonly available generator protocols to auto start and stop generator operation.

2.18. Balance of system

The Server has the following in-built in standard configuration:

- Lightning arrestor
- Static charge blocker
- Circuit breakers
- Fuses and safeties
- Connection busbar
- Low frequency isolation transformer

2.19. Safety

All necessary safeties are in-built in the Server, including over-charge protection, over–discharge protection, load short circuit protection, overload protection, and unique PV anti–polarity connected protection.

3. Operational Functionality

The section below describes the unique operational functionality of the Server and highlights the features that enable the Server to be deployed with storage and 100% renewable generation input to deliver power, 24-hours a day, in a stable, safe, resilient and economical manner.

3.1. Input Sources

The Server accepts the following input sources, delivering sequential or blended power:

- Renewable only (PV solar, wind, biomass, geothermal – concurrently or individually).
- Renewable (primary source) + grid (as a backup source).

- Renewable (primary source) + grid + genset (as backup sources).

3.2. Battery Storage

The Server accepts the following types of batteries:

- Lead Acid (AGM, Gel, Flooded)
- Lithium Ion
- Supercap

3.3. Battery Charging directly from Renewable Generation

- The Server accepts generation input that is 5x its rated power.
- With proper weather, this allows the batteries to be fully charged during sun-hours directly from renewable sources. This is a very powerful and unique feature.
- In case of availability of wind with PV solar, or other renewable sources, battery charging is optimized amongst the various sources.

3.4. System Stability

Frequency and voltage control, which is a significant challenge in independent deployments, is easily handled by the Server as follows:

3.4.1. In a typical deployment, the renewable input is sized to meet the daily 24-hour energy consumption of the load (this is possible due to the Server's ability to accept input that is 5x its rated capacity).

3.4.2. During generation hours, the load is being supplied directly from generation and excess generation (due to 5x sizing) is concurrently charging the storage.

3.4.3. The Server has a 0.00ms switching time between input sources, ensuring that a rapid response energy source is always available to the load to handle short-term intermittent generation events. (In case of longer deviations in generation such as unpredictable weather events, the Server's grid module or generator module start and control capabilities ensures system stability).

3.4.4. Finally, after generation hours, the load is supplied directly from the battery source. Which is a stable source of power.

3.5. Voltage and Frequency Referencing

To maintain a reliable reference for voltage and frequency, the Server relies on the inverter coupled with storage, which operates in voltage and frequency control mode to provide its own reference points.

3.6. Islanding / Anti-Islanding

The Server can island from the grid, and reconnect to the grid, responding directly to the signals from the utility. The transition is seamless, in either direction, and automated. This is a result of the Server's architecture and communication protocols.

3.7. Monitoring and Control

The Server delivers a comprehensive monitoring and control module that allows performance monitoring and fault detection and resolution to be monitored and controlled remotely. The control functionality enables user programmable operational policies.

4. Applications

A Server plus storage solution enables the delivery of 24-hour power based on renewable generation (rooftop solar, ground mounted solar, wind, biomass, geothermal), at an end-customer price that is equal to or less than grid based power in selected territories, delivering an acceptable return on investment to the network operator. The Server plus renewable

generation plus storage solution handles multiple input sources, manages renewable intermittency, voltage and frequency regulation and control, in one device, in one location. This enables a broad range of applications, which we briefly describe below:

4.1. Demand Growth

A Server based solution enables rapid building of capacity to meet demand growth. New residential communities, industrial parks, commercial centers, educational, military, entertainment sites etc. as well as projects that require extension of the distribution grid, building of new sub-stations and in certain cases, expansion of the transmission grid, can be provided power with Centauri based systems, operating primarily on renewable generation.

Due to the Server's exceptional capability of accepting multiple generation inputs, it provides the network operator significant flexibility in designing the system depending on availability of space and power sources.

4.2. Congestion Relief

For substations that are approaching congestion levels, individual residential, commercial and industrial consumers being serviced by the sub-station can be migrated to Centauri server + renewable + storage based systems at competitive unit ($/kWh) pricing (in select territories). This provides immediate congestion relief to the sub-station, reduces the need for large scale storage at the sub-station, defers technical upgrades, delivers a green solution to consumers with cost savings (in select territories), ensures continued revenue generation for the network operator and importantly, eliminates the need for net metering programs.

4.3. Remote Locations

Remote locations can be provided 24-hour power without having to build a grid infrastructure, with the ability to supply power at a significantly lower cost than fossil fuel generators. Due to the Server's ability to handle torque loads and accept high levels of renewable input, generator input is minimized and restricted to supporting bad weather events only, thereby making remote power cost effective and reliable and clean.

4.4. Critical Assets

Critical assets, such as military bases, hospitals, fire stations, police, rescue, data centers etc. can be secured from emergencies by deploying Server based systems. In an emergency, the Server's islanding functionality will isolate the critical asset and its seamless switching capability will ensure continuity of power from the other generation sources that are available. With the Server's ability to island, seamlessly switch to other input sources, handle torque load, remote monitoring and control capability, the critical assets can continue to function normally (as if there was no emergency) throughout the emergency and as long as alternative input generation sources continue to supply power.

4.5. Return on Investment and Capital Efficiency

The Server's ability to manage renewable intermittency, handle peak load, and deliver 100% renewable based power then enables the utility to design a cost-effective system for its customers, delivering power at competitive pricing (in select territories), reducing the need for power reserves and peaker plants, and ensuring an acceptable return on its capital.

It also enables fast go-to-generation times, which means shorter time to revenue generation.

Finally, and importantly, capital allocation is directly related to actual demand growth and not to forecasted demand growth, which results in higher capital efficiency.

4.6. Effective Deployment of DER's

Centauri Server based systems function independently. This is a viable alternative to existing grid-tied systems that cause technical disruption on the grid, and need the support of subsidized programs such as net metering to be financially viable. By deploying renewable + Server + storage based systems, utilities can profitably deploy DER's at the residential, commercial and industrial level, without any technical or financial disruption to the grid or network economics.

5. Application Schematic

The Server can be deployed in any location, for any kind of load profile, with grid or without grid access, with generator or without generator availability, from kW to MW. It does not require any layer of software or hardware to be added, however, if one exists, it can communicate with such hardware or software.